SCIENCE INSTRUMENT AIRWORTHINESS AND CERTIFICATION PROCEDURES MANUAL

Section 100: Introduction

100 Introduction

The primary purpose of FAA science instrument certification aboard SOFIA is SAFETY. The guidelines in this manual follow those of the Federal Aviation Administration (FAA) documents (FAR Part 25). The FAA is concerned with the safety of personnel associated with flight, and all aspects of the aircraft will be certified under FAA guidelines. Certification is not difficult, but it does require following specific steps from conceptual designs through instrument construction, installation, operations, and maintenance for the purpose of maintaining a safe environment aboard the Observatory.

The purpose of this airworthiness and certification procedures manual is to lead a SOFIA science instrument builder through the certification process with information and examples on all aspects of an instrument design that are required to comply with FAR Part 25 guidelines for certification. These requirements include mechanical and electrical design and analysis, instrument construction, testing, hazard identification and analysis, operations, and instrument maintenance. This manual has been compiled through the efforts of the SOFIA FAA SI Airworthiness IPT, which includes scientists, engineers, FAA Designated Engineering Representatives (DERs), and science instrument builders. Some processes and details have not been fully defined at this time, but will be inserted as they are produced. Instructions will evolve and become more detailed as the first instruments proceed through the certification process.

This Introduction will define the roles and responsibilities of those involved in the certification process. Section 100.1 has a short general list of required steps, from conceptual design review to conformity and compliance inspections. Section 100.2 describes the sections of this manual and Section 100.3 discusses scheduling.

Science Instrument Certification: Methods and Roles

Science instrument certification will involve communication between the science instrument (SI) team and the science instrument airworthiness Integrated Product Team (SIA-IPT) as mentioned above, the FAA Designated Engineering Representatives (DER), and the Designated Airworthiness Representatives (DAR). The Airworthiness IPT is responsible for the production of the material in this manual and also can be viewed as a resource for the SI builder on questions specific to instrument certification.

The Federal Aviation Administration is responsible for safety aboard all commercial and privately owned aircraft. The FAA appoints individuals to review designs, to make inspections, to review operations and maintenance, and to act on behalf of the FAA to review new designs and requirements for aircraft safety. DERs are supervised by the Aircraft Certification Office (ACO), while DARs are

supervised by the Manufacturing Inspections District Office (MIDO). SOFIA Operations will be monitored by the Certification Maintenance Office (CMO). The following sections discuss the roles and responsibilities that are held by each of these groups.

General information and the steps involved in FAA certification, from initiation of a certification project, through testing, conformity inspection, and award of a Supplemental Type Certificate (STC) are listed in Appendix III.

Designated Engineering Representative (DER)

The DER is a representative of the Federal Aviation Administration (FAA) and is quite knowledgeable in aircraft certification and all aspects concerning safety of flight. The DER is appointed and supervised by the cognizant FAA Aircraft Certification Office (ACO) which handles all engineering issues with respect to certification. The DERs have specific areas of expertise regarding safety, such as structural, electrical, mechanical, hazardous materials, etc., and are responsible for presenting the science instrument designs, documents, analysis, testing, etc., to the FAA in order to acquire the Supplemental Type Certificate (STC) required for flight aboard the observatory. The DER will aid the science instrument builder in developing the proper documentation package that will then be presented to the FAA. The documentation package will include design specifics, mechanical designs, stress analysis, electronic designs, hazard analysis, maintenance plans, operations scenarios, and any other item required to show compliance of the SI design to the FARs. The science instrument documentation package (or data package) will also include test plans that are required in order to certify a particular aspect of the system or subsystem. The DER will begin the process of identifying aspects of your instrument during the conceptual design review.

For SOFIA, the compliance check-list is kept by the administrative DER for the entire project and individual teams do not need to be concerned with this list. As designs become more detailed based on design reviews, the identification of critical items check list may involve several iterations with continual discussion between the science instrument builder, the Airworthiness IPT, and the DERs. Although the FAA has the right to witness any tests that are done, they can choose to designate a DER to witness a particular test.

DERs will assist the SI team in identifying the components of a system that will require testing.

Designated Airworthiness Representative (DAR)

Another very important aspect in the certification process is the finding of ‘Conformity.’ Conformity is an inspection process in which it is determined whether or not the physical instrument conforms to (is the same as) the design data in terms of dimensions and materials. The conformity inspection is conducted by an FAA MIDO inspector or the inspection is delegated to a DAR.

The DAR is appointed and supervised by the Manufacturing Inspection District Office (MIDO) and is responsible for inspections of all parts, test set up, and other conformity issues. Once your design is complete and before you begin to build, drawings and a request for conformity are submitted to the FAA ACO by the DER. The ACO will then contact the MIDO and the request for conformity will be issued to the DAR, who is then responsible for conducting the conformity inspection. A conformity inspection of a part means that all dimensions, materials, process call outs, and tolerances are checked to make sure that they are exactly as have been specified on the drawing.

Compliance vs. Conformity

The FARs are the rules that must be followed to obtain certification. Compliance with the rules is determined by the DERs working in conjunction with the engineers of the FAA ACO. Compliance is determined by reviewing the documentation provided by the SI team, by conducting any required tests, and by conducting a 'Compliance' inspection on the aircraft. 'Conformity,' however, is the determination by the DAR that the parts that are to be installed on the aircraft are the same in every particular as the design that is defined by the engineering data.

Operations: Flight Standards District Office

Once your instrument has received its STC, and during SOFIA operations the FAA office that will be responsible for the training of personnel, continued Airworthiness, etc. is the Flight Standards District Office (FSDO). This office is charged with oversight of the maintenance of the aircraft and subsystems (including SIs) on board the aircraft. More information will be forthcoming on the topic of operations and continued Airworthiness.

100.1 Science Instrument Certification: General Process/Overview

Certification of a science instrument will involve several reviews and iterations of drawings, procedures, and analyses before obtaining DER approval. While the reviews are not an FAA requirement, it is the proper tool for the science instrument teams to use for communications between the teams and the DERs and between the DERs and the SI teams.

The following list is intended as a very brief overview of the airworthiness requirements and reviews. A more detailed description can be found in Section 150.

Conceptual Design Review (CODR)

Conceptual design review is to give information on the overall system design and begin to identify critical safety issues. This is the first opportunity to show the DERs and other reviewers the mechanical and electrical specifications

and to discuss instrument hazards. The outcome of this review should be a list of action items that need further details or analysis. There may also be action items for the DER and IPT that address elements of this manual that are incomplete or required clarification to these requirements. These may include discussion of particular instrument hazards such as cryogen use, calibration gases, and failure modes.

Preliminary Airworthiness Design Review (PADR)

The preliminary design review will begin with submission of a documentation package to the Airworthiness IPT. The IPT will determine to first order whether or not further details are required and if found sufficient, pass the documents on to the DER for review a couple of weeks prior to the scheduled PDR date. Review and presentation topics are a more detailed presentation of the material shown during the CODR.

Critical Airworthiness Design Review (CADR).

This review is for final approval from the DER, before construction is to begin. The CADR should occur after you have achieved 90% completion of the data package—drawings, analysis, etc. The topics covered in the CADR are the same as those in the PADR but with all the iterations and improvements to drawings and documentation as required by the DERs. The FAA inspector, a Designated Airworthiness Representative (DAR), will also attended the CADR meeting to initiate communication between the science team and the FAA DAR.

Following the CADR there will be opportunity for documentation clean up (drawings and reports) and re-submittal of those documents to the DERs for their review. If found acceptable, the DERs will provide FAA approval of the documents. The science teams can now proceed to manufacturing and testing.

Construction, Inspection, and Testing.

This phase of the program will include part manufacturing, part conformity inspection, and testing.

During the part manufacturing phase, some or all parts will require part conformity by an FAA DAR. Additionally, conformity will be required at sub-assembly and final assembly phases. The scheduling of conformities must be closely coordinated with the Airworthiness IPT and the FAA DAR.

Part or assembly testing (such as proof & burst) will require 100% FAA conformity of the unit, FAA approval of the test plan, and 100% FAA conformity of the test setup prior to commencing testing. It also requires that the FAA (or delegated DER) witness the test.

Obtaining Final Certification

Successful part or assembly testing are complete by FAA DER approval of the documented results. The science teams now must submit the final airworthiness deliverables (see section 150.6) for DER review and approval. This includes the Electro-magnetic Interference (EMI) and Functional tests.

The EMI and Functional are ground and flight based tests to ensure there is no interference with the aircraft electrical system and the science instrument operates properly as per design. Similar to the part or assembly test, these tests will require 100% FAA conformity of the entire science instrument assembly/installation FAA approval of the test plan. It also requires that the FAA (or delegated DER) witness the test.

Successful EMI and Functional tests are complete by FAA DER approval of the documented results. With the approved results submitted to the FAA, this concludes the certification process with the issuance of the Supplemental Type Certificate (STC).

100.2 Certification Procedures Manual

This SI Airworthiness Certification Procedures Manual is separated into sections to address all possible aspects of the science instrument as follows:

Section 100: Introduction:

This section is an introduction to certification, methods, and role of the participants. A short list of steps as well as an overview of the review process is also included.

Section 150: Reviews

This section addresses in detail the review process that has been developed to facilitate the science instrument certification process.

Section 200: Documentation

The first important aspect of certification is the documentation. Section 200 has examples of title blocks and information on a possible numbering scheme for instrument designers. It is not required that the procedures be strictly followed, but similarity between instruments is key to streamlining this certification process.

Section 300: Mechanical

This section is dedicated to outlining the mechanical drawings and analysis that will be required for each component of the instrument.

Section 350: Manufacturing

This section addresses some of the more specific tasks that will be required during SI manufacturing. It includes process specifications, discrepancy reports, and a sample test plan flow chart.

Section 400: Electrical

The electronics subsystems within the SIs are largely low power signal processing electronics. All SI electronics are nonessential equipment for aircraft operation and so certification involves simple safety concerns. This section of the manual provides guidelines for design, documentation, failure analysis, and testing of electronics components.

Section 500: Functional Hazard Analysis

Functional hazard analysis is required for each science instrument, and the necessary FAA hazard reporting forms and examples are included in this section.

Section 600: Operational Procedures and Maintenance (Continued Airworthiness)

This section addresses the maintenance and operation of the science instrument. Maintenance, operations, and continued airworthiness are very much connected under FAR Part 121, and therefore sections 600 and 700 have been combined. This section provides some guidance and references for writing and maintaining a log book and maintenance manual for the science instruments.

100.3 Schedule

Schwartz Engineering has provided a sample Gantt chart outlining a typical certification schedule. The exact dates will be specified by each science instrument team and included in the Airworthiness Documentation Logbook by the science team. This example is intended as a guide, to help SI teams develop an instrument timeline. The Gantt chart illustrates milestones and tasks, which are driven by these milestones. For example, the detailed SI layout, preliminary FHA analysis, and the preliminary stress analysis will be presented at the PADR. Information will be provided pertaining to the items on the Gantt chart, which clarifies each of the required tasks as soon as possible.

The Gantt chart immediately follows this Introduction.